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(54) **REMEDIES FOR CHRONIC KIDNEY DISEASES**

(57) A therapeutic agent for chronic kidney diseases, which comprises as an active ingredient a compound capable of inhibiting Na⁺/Ca²⁺ exchanger 1.

EP 1 475 103 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to novel therapeutic agents for chronic kidney diseases.

BACKGROUND ART

[0002] Intracellular free Ca^{2+} is an important ion for controlling the contraction of cardiac muscle and various smooth muscles, the release of neurotransmitters, and the expression of genes. The concentration of such Ca^{2+} ion is regulated by Ca^{2+} pumps, Ca^{2+} channels and/or $\text{Na}^{+}/\text{Ca}^{2+}$ exchangers (NCX) present in the plasma membrane and the sarcoplasmic reticulum membrane. Among them, $\text{Na}^{+}/\text{Ca}^{2+}$ exchangers play a particularly important role in the contraction and relaxation of cardiac muscle and vascular smooth muscle (Ann. Rev. Physiol., vol. 52, p. 467 (1990)). At present, three NCX genes have been isolated and identified from mammals. Moreover, it is known that NCX1 protein is expressed at high levels in the brain, heart and kidney, NCX2 protein is expressed primarily in the brain and also expressed, but slightly, in visceral smooth muscle, and NCX3 protein is expressed primarily in the brain and also expressed, but slightly, in skeletal muscle (Jpn. J. Circ. Res, vol. 24, no. 3, p. 101 (2001); Am. J. Physiol., 272, C1250-C1261 (1997)).

[0003] As for NCX inhibitors, isothiourea derivatives such as 2-[2-[4-[nitrobenzyloxy] phenyl] ethyl] isothio - ureamethanesulfonate (K-BR7943) and phenoxyaniline derivatives such as 2-[4-[(2,5-difluorophenyl)methoxy] phenoxy]-5-ethoxyaniline (SEA0400) have been reported, and K-BR7943 has been confirmed to have efficacy in acute myocardial infarction models as well as brain and kidney ischemia/reperfusion models (J. Pharmacol. Exp. Ther., vol. 296, p. 412 (2001)). However, there is no report about the application of NCX inhibitors as therapeutic agents for chronic kidney diseases.

DISCLOSURE OF THE INVENTION

[0004] The inventors of the present invention investigated the NCX-inhibiting activity of K-BR7943, SEA0400 and other compounds by using $\text{Na}^{+}/\text{Ca}^{2+}$ exchangers (NCX) prepared from brain, heart and kidney. As a result, it has been found that phenoxyaniline derivatives (including SEA0400) and phenoxy pyridine derivatives selectively inhibit NCX derived from the heart and kidney, as compared with NCX derived from brain tissue.

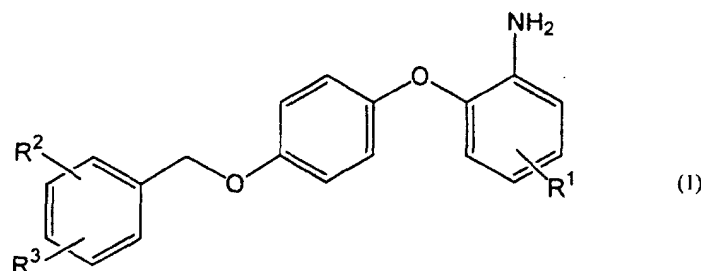
[0005] In addition, previous studies have reported that the above-mentioned compounds had little effect on other receptors, channels and transporters, at a concentration sufficient to inhibit NCX (J. Pharmacol. Exp. Ther., vol. 298, p. 249 (2001)).

[0006] In view of the foregoing, phenoxyaniline derivatives and the like are found to have high selectivity for NCX1.

[0007] With the aim of elucidating the relationship between NCX1 and diseases or their treatment, the inventors of the present invention made further investigation in various disease models (e.g., chronic kidney failure/glomerulosclerosis model, diabetic rat) using the above NCX1-selective inhibitors. As a result, it has been found that inhibition of NCX1 is effective for the renal protection in chronic kidney failure, glomerulosclerosis and diabetic nephropathy. These findings led to the completion of the present invention.

[0008] Namely, the present invention is directed to a therapeutic agent for chronic kidney diseases, which comprises as an active ingredient a compound capable of inhibiting $\text{Na}^{+}/\text{Ca}^{2+}$ exchanger 1.

[0009] Further, the present invention is directed to a therapeutic agent for chronic kidney diseases, which comprises as an active ingredient a 2-phenoxyaniline derivative of Formula (1):



[wherein R^1 represents a hydrogen atom or a $\text{C}_1\text{-C}_6$ alkoxy group, R^2 represents a halogen atom or a nitro group, and R^3 represents a hydrogen atom or a halogen atom] or a pharmaceutically acceptable salt thereof.

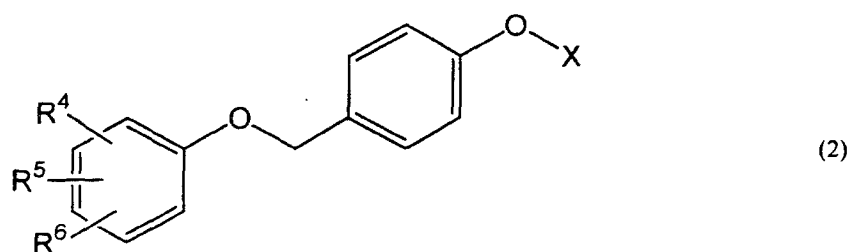
BEST MODE FOR CARRYING OUT THE INVENTION

[0010] In the present invention, NCX1 inhibiting compounds are not limited as long as they inhibit kidney-derived NCX1, preferred are those which produce greater than 50% inhibition at a concentration of 3 μ M when assayed by the test described later (Reference Example 3). In terms of avoiding side effects, more preferred are compounds capable of specifically inhibiting NCX1.

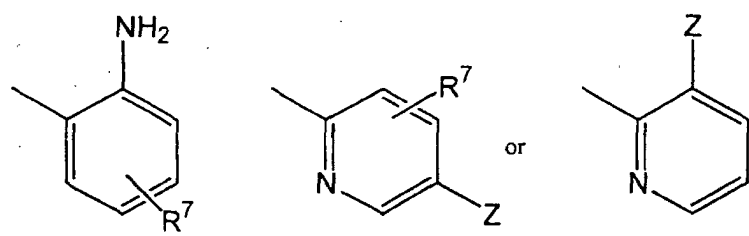
[0011] The compound capable of specifically inhibiting NCX1 means a compound that does not substantially inhibit other receptors, channels and transporters at a concentration sufficient to inhibit NCX1. More specifically, for example, when used at a concentration of 3 μ M, such a compound preferably does not cause greater than 50% inhibition of Ca^{2+} channels; Na^{+} channels, K^{+} channels, $\text{Na}^{+}/\text{H}^{+}$ transporters, norepinephrine transporters, $\text{Na}^{+}, \text{K}^{+}$ -ATPase, Ca^{2+} -ATPase, phospholipase A_2 , phospholipase C, 5-lipoxygenase, inducible nitric-oxide synthetase, constitutive nitric-oxide synthetase, Adenosine receptors, Adrenergic receptors, Glutamate receptors, Bradykinin receptors, LTB4 receptors or PAF receptors. It should be noted that procedures for measurement using these individual ion channels, enzymes and receptors are disclosed in J. Pharmacol. Exp. Ther., vol. 298, p. 249 (2001) and references cited therein.

[0012] Examples of the compound capable of specifically inhibiting NCX1 include phenoxyaniline derivatives and phenoxy pyridine derivatives.

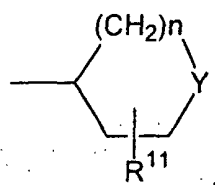
[0013] Preferred are compounds of Formula (2):



[wherein R^4 , R^5 and R^6 , which may be identical or different, each represent a hydrogen atom or a halogen atom, X represents:



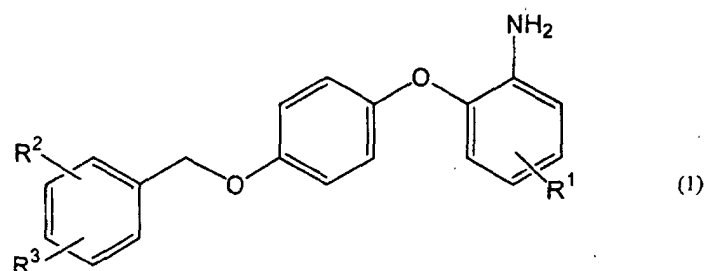
R^7 represents a hydrogen atom, a substituted or unsubstituted C_1 - C_6 alkyl group or a substituted or unsubstituted C_1 - C_6 alkoxy group, Z represents a nitro group, an amino group or a $\text{NHC}(\text{O})\text{CH}_2\text{R}^8$ group, R^8 represents a hydrogen atom, a substituted or unsubstituted C_1 - C_6 alkyl group, a substituted or unsubstituted C_1 - C_6 alkoxy group, a halogen atom, a hydroxy group, a C_2 - C_7 acyloxy group, NR^9R^{10} or



R^9 and R^{10} , which may be identical or different, each represent a hydrogen atom, a substituted or unsubstituted C_1 - C_6 alkyl group or an N-methyl-4-piperidynyl group, R^{11} represents a hydrogen atom, a hydroxy group or a C_2 - C_7 alkoxy-carbonyl group, Y represents a methylene group, an epoxy group, a thio group or a NR^{12} group, n represents an integer of 1 to 4, and R^{12} represents a hydrogen atom, a substituted or unsubstituted C_1 - C_6 alkyl group or a substituted or

unsubstituted phenyl group] or a pharmaceutically acceptable salt thereof.

[0014] In terms of NCX1-inhibiting activity, more preferred are 2-phenoxyaniline derivatives of Formula (1):



[wherein R¹ represents a hydrogen atom or a C₁-C₆ alkoxy group, R² represents a halogen atom or a nitro group, and R³ represents a hydrogen atom or a halogen atom] or a pharmaceutically acceptable salt thereof.

[0015] In Formulae (1) and (2), a C₁-C₆ alkoxy group means a linear or branched alkoxy group containing 1 to 6 carbon atoms. Examples include a methoxy group, an ethoxy group, a propoxy group, an isopropoxy group, a butoxy group, an isobutoxy group, a sec-butoxy group, a tert-butoxy group, a pentyloxy group, an isopentyloxy group, a neopentyloxy group, a tert-pentyloxy group, a 1-methylbutoxy group, a 2-methylbutoxy group, a 1,2-dimethylpropoxy group, a hexyloxy group and an isohexyloxy group.

[0016] Examples of a substituent for the substituted C₁-C₆ alkoxy group include a chloro group, a fluoro group, a nitro group, an amino group, a dimethylamino group, a carboxyl group, a methoxycarbonyl group, an ethoxycarbonyl group, a phenyl group, a hydroxy group, a cyano group and a carbamoyl group.

[0017] A halogen atom refers to a fluorine atom, a chlorine atom, a bromine atom or an iodine atom.

[0018] A C₁-C₆ alkyl group means a linear or branched alkyl group containing 1 to 6 carbon atoms. Examples include a methyl group, an ethyl group, a propyl group, an isopropyl group, a butyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, a pentyl group, an isopentyl group, a neopentyl group, a tert-pentyl group, a 1-methylbutyl group, a 2-methylbutyl group, a 1,2-dimethylpropyl group, a hexyl group and an isohexyl group.

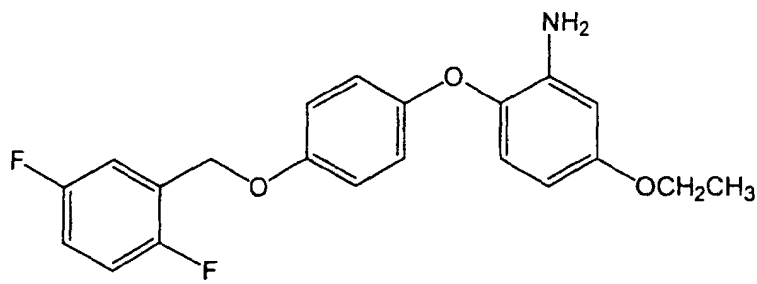
[0019] Examples of a substituent for the substituted C₁-C₆ alkyl group include a chloro group, a fluoro group, a nitro group, an amino group, a dimethylamino group, a carboxyl group, a methoxycarbonyl group, an ethoxycarbonyl group, a phenyl group, a methoxy group, an ethoxy group, a hydroxy group, a cyano group and a carbamoyl group.

[0020] A C₂-C₇ acyloxy group means a linear or branched acyloxy group containing 2 to 7 carbon atoms, whose acyl moiety may be cyclic or may contain an aromatic group. Examples include an acetoxy group, a propionyloxy group, an isopropionyloxy group, a cyclohexyloxy group and a benzoyloxy group.

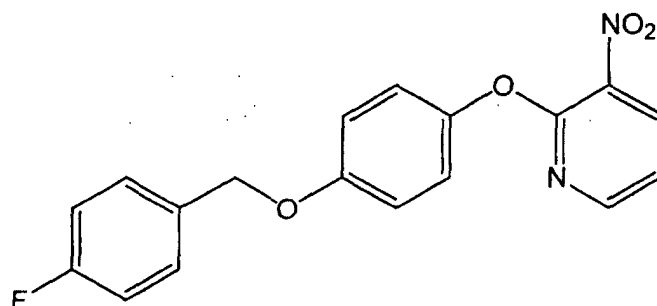
[0021] A C₂-C₇ alkoxycarbonyl group means a linear or branched alkoxycarbonyl group containing 2 to 7 carbon atoms, whose alkoxyl moiety may be cyclic or may contain an aromatic group. Examples include a methoxycarbonyl group, an ethoxycarbonyl group, a propoxycarbonyl group, an isopropoxycarbonyl group, a butoxycarbonyl group, an isobutoxycarbonyl group, a sec-butoxycarbonyl group, a tert-butoxycarbonyl group, a pentyloxycarbonyl group, an isopentyloxycarbonyl group, a neopentyloxycarbonyl group, a tert-pentyloxycarbonyl group, a 1-methylbutoxycarbonyl group, a 2-methylbutoxycarbonyl group, a 1,2-dimethylpropoxycarbonyl group, a hexyloxycarbonyl group and an isohexyloxycarbonyl group.

[0022] Examples of a substituent for the substituted phenyl group include a chloro group, a fluoro group, a nitro group, an amino group, a dimethylamino group, a carboxyl group, a methoxycarbonyl group, an ethoxycarbonyl group, a methyl group, an ethyl group, a methoxy group, an ethoxy group, a hydroxy group, a cyano group and a carbamoyl group.

[0023] Examples of compounds having an excellent activity for kidney protect are the compound shown below (SEA0400)



and
the compound shown below (SEA0064).



[0024] Moreover, to avoid side effects, such compounds preferably produce stronger inhibition on NCX1 than on NCX2 and NCX3. For example, the compounds that have smaller values of IC_{50} (renal cortex-derived) / IC_{50} (brain-derived), and IC_{50} (renal cortex-derived) / IC_{50} (cardiac sarcolemma-derived), when measured as described later, than SEA 0400 are preferred.

[0025] It should be noted that the compounds of Formulae (1) and (2) can be synthesized according to the procedures as described in WO98/43943, WO99/20598, Japanese Laid-Open Patent *Hei* 10-265460, Japanese Laid-Open Patent *Hei* 10-218844, Japanese Laid-Open Patent *Hei* 11-49752 and Japanese Laid-Open Patent *Hei* 11-92454.

[0026] As used herein, the therapeutic agent for a chronic kidney disease of the present invention means a therapeutic agent for a chronic kidney disease which deteriorates the physiological function of kidney including chronic kidney failure, glomerulosclerosis, diabetic nephropathy, nephrosclerosis, chronic nephritis, chronic glomerulonephritis, polycystic kidney disease and the like, and can achieve excellent kidney protective activity such as decreasing the protein and albumin in urine.

[0027] The therapeutic agent of the present invention can be prepared as a pharmaceutical composition in any desired dosage form for oral or parenteral use (e.g., tablets, pills, capsules, granules, dry syrups, injectable preparations), in combination with known carriers, diluents and so on, as appropriate.

[0028] Solid preparations can be prepared by stirring granulation, fluidized-bed granulation or milling granulation using various additives such as excipients, disintegrating agents, binders, lubricants and coating bases.

[0029] If necessary, it is also possible to add other additives such as antioxidants, coating agents, coloring agents, flavoring agents, surfactants and plasticizers.

[0030] The dose of the active ingredient in the pharmaceutical preparation of the present invention will vary depending on age, body weight, dosage form, and so on, but the usual dose to an adult is 0.1 to 1000 mg/day, which can be administered once or several times a day.

[0031] The present invention will now be described with reference to the following Formulation Examples and Test Examples, which are not intended to limit the scope of the invention.

Formulation Example 1	
SEA0400	50 mg
Lactose	40 mg

EP 1 475 103 A1

(continued)

Formulation Example 1	
Corn starch	49.75 mg
Crystalline cellulose	17 mg
Carmellose calcium	17 mg
Hydroxypropylcellulose	5.25 mg
Magnesium stearate	1 mg
Total	180 mg

[0032] SEA0400, lactose, corn starch, crystalline cellulose and carmellose calcium were mixed uniformly, followed by addition of a 10% aqueous hydroxypropylcellulose solution. After kneading and drying, the resulting granules were passed through a 30M sieve to give uniform granules, which were then supplemented with magnesium stearate and tabletted into tablets.

Formulation Example 2	
SEA0064	50 mg
Lactose	40 mg
Corn starch	49.75 mg
Crystalline cellulose	17 mg
Carmellose calcium	17 mg
Hydroxypropylcellulose	5.25 mg
Magnesium stearate	1 mg
Total	180 mg

[0033] SEA0064, lactose, corn starch, crystalline cellulose and carmellose calcium were mixed uniformly, followed by addition of a 10% aqueous hydroxypropylcellulose solution. After kneading and drying, the resulting granules were passed through a 30M sieve to give uniform granules, which were then supplemented with magnesium stearate and tabletted into tablets.

Reference Example 1 Method of measuring for brain microsomal $\text{Na}^+/\text{Ca}^{2+}$ exchanger

[0034] Brain microsomes (1.5 mg/ml) obtained from 8-week-old rats were pre-treated with 160 mM NaCl-containing buffer to cause Na loading into membrane vesicles. This suspension was diluted 50-fold with 20 μM $^{45}\text{CaCl}_2$ -containing buffer to induce ^{45}Ca uptake, followed by dilution with the buffer (0°C) to stop the reaction. The membrane vesicles were immediately collected on a nitrocellulose filter. Subsequently, ^{45}Ca trapped inside the membrane vesicles was determined by liquid scintillation counting. The above assay for $\text{Na}^+/\text{Ca}^{2+}$ exchange activity in brain microsomes was performed according to the procedures described in J. Biol. Chem., vol. 257, p. 5111 (1982).

Reference Example 2 Method of measuring for canine cardiac sarcolemmal vesicle $\text{Na}^+/\text{Ca}^{2+}$ exchanger

[0035] Canine cardiac sarcolemmal vesicles (0.5 mg/ml) were prepared by centrifugal fractionation as described in Methods enzymology, vol. 157, p. 85 (1988) and suspended in Solution A (20 mM MOPS-Tris (pH 7.4), 160 mM NaCl or KCl), followed by incubation at room temperature for about one hour to cause Na or K loading into the vesicles. This suspension was diluted 50-fold with 20 μM $^{45}\text{CaCl}_2$ -containing buffer to induce ^{45}Ca uptake, followed by dilution with the buffer (0°C) to stop the reaction. The membrane vesicles were immediately collected on a nitrocellulose filter. Subsequently, ^{45}Ca trapped inside the membrane vesicles was determined by liquid scintillation counting. The $\text{Na}^+/\text{Ca}^{2+}$ exchange activity was evaluated by subtracting the value obtained for K loading from the value obtained for Na loading. The above assay for $\text{Na}^+/\text{Ca}^{2+}$ exchange activity in canine cardiac sarcolemmal vesicles was performed according to the procedures described in J. Biol. Chem., vol. 257, p. 5111 (1982).

Reference Example 3 Preparation of rat renal cortex-derived BLMVs (basolateral membrane vesicles) and method of measuring for their $\text{Na}^+/\text{Ca}^{2+}$ exchange activity

(Preparation of BLMVs)

[0036] BLMVs were prepared from rat renal cortex and assayed for $\text{Na}^+/\text{Ca}^{2+}$ exchange activity according to the procedures described in Am. J. Physiol., vol. 266, p. F785 (1994).

[0037] After being excised from rats, the kidneys were placed in ice-cold sucrose buffer (0.25 mM sucrose, 0.1 mM PMSF, 10 mM Tris-HCl (pH 7.6)) and decapsulated. The isolated cortex was then finely minced in the sucrose buffer and homogenized sequentially with a Dounce-type homogenizer and a Polytron-type homogenizer, followed by centrifugation at 2500 g for 15 minutes to collect the supernatant. Centrifugation was repeated at 24000 g for 20 minutes to collect the white fluffy portion of the pellet. After further addition of the sucrose buffer, the collected fraction was homogenized with a Dounce-type homogenizer, supplemented with Percoll and then centrifuged at 30000 g for 35 minutes to collect the middle layer. After addition of buffer (100 mM KCl, 100 mM mannitol, 5 mM HEPES-Tris (pH 7.4)), centrifugation was carried out at 34000 g for 30 minutes to collect the loose white pellet (BLMVs). The pellet was further suspended in the KCl-mannitol buffer and then centrifuged at 34000 g for 30 minutes to collect the precipitate, which was used for activity assay.

(Method of measuring for $\text{Na}^+/\text{Ca}^{2+}$ exchanger (Na-dependent ^{45}Ca uptake))

[0038] The BLMVs thus prepared were equilibrated at 37°C for 10 minutes in pre-equilibration buffer (100 mM NaCl, 40 mM KCl, 1 mM MgSO_4 , 10 mM glucose, 5 mM HEPES-Tris (pH 7.4)) and then centrifuged at 20000 g for 5 minutes to collect the precipitate, which was then resuspended in the pre-equilibration buffer. Centrifugation was repeated to collect the precipitate, followed by resuspension in the pre-equilibration buffer. The resulting BLMV suspension was diluted 20-fold with external medium (100 mM choline chloride, 40 mM KCl, 1 mM MgSO_4 , 10 mM glucose, 5 mM HEPES-Tris (pH 7.4), 25 μM valinomycin, 10 μM CaCl_2 , 1 mCi/ $^{45}\text{CaCl}_2$) to start uptake. After reaction at 25°C for a given period of time, 2 ml stop solution (ice-cold 150 mM KCl) was added to stop the reaction, and the reaction mixture was immediately filtered through an ultrafiltration membrane (0.45 μm nitrocellulose filter) to collect BLMVs on the filter. Subsequently, the filter was washed twice with 2 ml stop solution and then the amount of ^{45}Ca trapped inside the BLMVs was determined by using liquid scintillation method.

Table 1

Inhibitory activity against $\text{Na}^+/\text{Ca}^{2+}$ exchange (Na-dependent ^{45}Ca uptake)			
(IC ₅₀ value: μM)			
	Brain	Cardiac sarcolemma	Renal cortex
K-BR7943	11.0	7.0	6.8
SEA0400	0.2	0.09	0.02

[0039] Likewise, SEA0064 was also confirmed to show an inhibitory activity of about 0.07-fold of SEA0400, by measuring for renal cortex-derived $\text{Na}^+/\text{Ca}^{2+}$ exchange activity.

Test Example 1: Kidney protective activity of $\text{Na}^+/\text{Ca}^{2+}$ exchange system inhibitor in Dahl-salt sensitive rat

[0040] This test was conducted following the method described in J. Cardiovascular Pharmacology, Vol. 23, p. 970 (1994). Specifically, procedures are as follows.

<Method>

[0041] Dahl-salt sensitive (Dahl-S) rats and Dahl-salt resistant (Dahl-R) rats as control animals (male, 7 weeks old) were used for the experiment. The rats were divided into 3 groups (6 individuals for each group) for the test.

Group I: Dahl-R + 4% NaCl chow + solvent orally administered (twice a day)

Group II: Dahl-S + 4% NaCl chow + solvent orally administered (twice a day)

Group III: Dahl-S + 4% NaCl chow + SEA0400 10 mg/kg orally administered (twice a day)

[0042] Each animal was fed with a 4% NaCl high-salt-containing chow (whereas normal chow contains 0.6% NaCl) and water ad libitum. The solvent and SEA0400 were orally administered twice a day (first time at 8:30 to 9:30 and second time at 16:30 to 17:30) for consecutive 6 weeks. In 6 weeks after the administration started, each of the rats was placed in a metabolic cage where urine was taken so that the amounts of protein and albumin in urine were measured to observe the effect on the kidney function. Determination of the amounts of protein and albumin in urine was performed following the method described in Bunseki Kagaku, Vol. 32, pp. E379-E386 (1983) and Hypertension, Vol. 40, No. 6, pp. 834-839 (2002) using an autoanalyzer (HITACHI Automatic Analyzer 7060).

[0043] The amounts of urinary protein excretion in 6 weeks after the test started were 23 ± 2 mg/day for Group I and 144 ± 11 mg/day for Group II but 91 ± 12 mg/day for SEA0400 administered group (Group III), which value was significantly lower than that of the solvent administered group (Group II).

[0044] The amounts of urinary albumin excretion were 2 ± 1 mg/day for Group I and 109 ± 14 mg/day for Group II but 58 ± 8 mg/day for SEA0400 administered group (Group III), which value was significantly lower than that of the solvent administered group (Group II).

[0045] These results demonstrated that SEA0400 significantly inhibited the increase in urinary protein and albumin excretion observed in Dahl-S rats and exhibited kidney protective activity.

[0046] Test Example 2: Kidney protective activity of $\text{Na}^+/\text{Ca}^{2+}$ exchanger inhibitor in spontaneous diabetic rats (ZSF-1)

<Method>

[0047] ZSF-1 rats are spontaneous diabetic rats and are known to exhibit renal dysfunction (Renal Failure, Vol. 22, No. 4, pp. 387-406 (2000)). ZSF-1 rats and ZSF-1/lean rats which were control animals (8 weeks old) obtained from The Jackson Laboratory were used for this test. The rats were divided into 5 groups (8 individuals for each group) for the test.

Group I: ZSF-1/lean + solvent orally administered (twice a day)

Group II: ZSF-1 + solvent orally administered (twice a day)

Group III: ZSF-1 + SEA0400 1 mg/kg orally administered (twice a day)

Group IV: ZSF-1 + SEA0400 3 mg/kg orally administered (twice a day)

Group V: ZSF-1 + SEA0400 10 mg/kg orally administered (twice a day)

[0048] The solvent and SEA0400 were orally administered twice a day (first time at 8:30 to 10:30 and second time at 16:30 to 18:30) for consecutive 8 weeks. Eight weeks after the administration started, each of the rats was placed in a metabolic cage where urine was taken so that the amounts of protein and albumin in urine were measured to observe the effect on the kidney function. Determination of the amounts of protein and albumin was performed following the description of the above-mentioned references using an autoanalyzer (HITACHI 7060 Automatic Analyzer).

[0049] The amounts of urinary protein excretion in 8 weeks after the test started were 14 ± 1 mg/day for Group I; 58 ± 9 mg/day for Group II; 40 ± 8 mg/day for Group III; 37 ± 7 mg/day for Group IV; and 29 ± 5 mg/day for Group V, and the value of the group administered with 10 mg/kg of SEA0400 (Group V) was significantly lower than that of the solvent administered group (Group II).

[0050] The amounts of urinary albumin excretion were 1 ± 0.1 mg/day for Group I; 28 ± 5 mg/day for Group II; 20 ± 5 mg/day for Group III; 17 ± 5 mg/day for Group IV; and 9 ± 2 mg/day for Group V, and the value of the group administered with 10 mg/kg of SEA0400 (Group V) was significantly lower than that of the solvent administered group (Group II).

[0051] These results demonstrated that SEA0400 significantly inhibited the increase in urinary protein and albumin excretion as observed in spontaneous diabetic rats and exhibited kidney protective activity.

Industrial Applicability

[0052] The present invention enables to provide therapeutic agents for chronic kidney diseases based on a novel action mechanism and it is useful for treating and preventing chronic kidney diseases with fewer side effects.

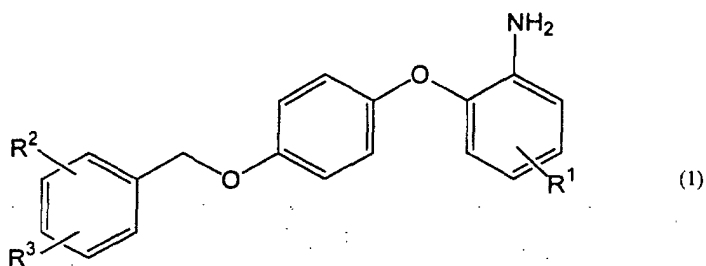
Claims

1. A therapeutic agent for chronic kidney diseases, which comprises as an active ingredient a compound capable of inhibiting $\text{Na}^+/\text{Ca}^{2+}$ exchanger 1 (NCX1).

2. A therapeutic agent for chronic kidney diseases, which comprises as an active ingredient a compound capable of

specifically inhibiting $\text{Na}^+/\text{Ca}^{2+}$ exchanger 1 (NCX1).

3. A therapeutic agent for chronic kidney diseases, which comprises as an active ingredient a 2-phenoxyaniline derivative of Formula (1):



[wherein R^1 represents a hydrogen atom or a C_1 - C_6 alkoxy group, R^2 represents a halogen atom or a nitro group, and R^3 represents a hydrogen atom or a halogen atom] or a pharmaceutically acceptable salt thereof.

4. A method for treating or preventing chronic kidney diseases **characterized in** inhibiting $\text{Na}^+/\text{Ca}^{2+}$ exchanger 1 (NCX1).
5. Use of a compound capable of inhibiting $\text{Na}^+/\text{Ca}^{2+}$ exchanger 1 (NCX1) for protecting kidney in the treatment of chronic kidney diseases.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP03/00675

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ A61K45/00, 31/09, A61P13/12 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) Int.Cl ⁷ A61K45/00, 31/09 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) MEDLINE (STN), CAPLUS (STN), BIOSIS (STN), EMBASE (STN), REGISTRY (STN), CAOLD (STN)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2000-355537 A (Taisho Pharmaceutical Co., Ltd.), 26 December, 2000 (26.12.00), Claim 3; examples (Family: none)	1-3
X	EP 1031556 A1 (Taisho Pharmaceutical Co., Ltd.), 30 August, 2000 (30.08.00), Claim 7, examples & WO 99/20598 A1 & CA 2305734 A & AU 9894638 A1 & JP 11-193263 A & US 6162832 A	1-3
X	JP 11-092454 A (Taisho Pharmaceutical Co., Ltd.), 06 April, 1999 (06.04.99), Claim 3; examples (Family: none)	1-3
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed		"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
Date of the actual completion of the international search 15 April, 2003 (15.04.03)		Date of mailing of the international search report 30 April, 2003 (30.04.03)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP03/00675

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Takahiro IWAMOTO et al., "Kitai sareru Calcium Chiryoyaku <Na ⁺ /Ca ²⁺ >Kokantai Sogaiyaku", CLINICAL CALCIUM, 2001, Vol.11, No.6, pages 784 to 789, abstract	1-3
X	JP 11-049752 A (Taisho Pharmaceutical Co., Ltd.), 23 February, 1999 (23.02.99), Claims 3, 4 (Family: none)	1,2
X	EP 978506 A1 (Taisho Pharmaceutical Co., Ltd.), 09 February, 2000 (09.02.00), Claims 6, 7 & WO 98/43943 A1 & AU 9865187 A1 & JP 10-324669 A & US 6156801 A	1,2
X	JP 10-245336 A (Taisho Pharmaceutical Co., Ltd.), 14 September, 1998 (14.09.98), Claim 1; Par. No. [0001] (Family: none)	1,2
X	JP 11-302235 A (Taisho Pharmaceutical Co., Ltd.), 02 November, 1999 (02.11.99), Par. No. [0003] (Family: none)	1,2
X	JP 10-218844 A (Taisho Pharmaceutical Co., Ltd.), 18 August, 1998 (18.08.98), Claim 1; Par. No. [0001] (Family: none)	1,2
X	YAMASHITA Junji et al., Pre- or Post-Ischemic Treatment with a Novel Na ⁺ /Ca ²⁺ Exchange Inhibitor, KB-R7943, Shows Renal Protective Effects in Rats with Ischemic Acute Renal Failure, Journal of Pharmacology and Experimental Therapeutics, 2001, Vol.296, No.2, pages 412 to 419, ABSTRACT	1,2
X	Yasuo MATSUMURA, "Jin Kyoketsu Saikanryu Shogai: Hassho, Shinten Kiko to Shogai Kaizenyaku", Pharmacometrics, 2001, Vol.60, No.4, pages 103 to 106, abstract	1,2
P,X	WO 02/34250 A1 (Taisho Pharmaceutical Co., Ltd.), 02 May, 2002 (02.05.02), & AU 2001/095973 A	1-3
P,X	Takahiro IWAMOTO et al, "Idenshi Kaihen Mouse o Mochiita Na ⁺ /Ca ²⁺ Kokan Yusotai no Kino Kaiseki to Soyaku", Folia Pharmacologica Japonica, 10 November, 2002 (10.11.02), Vol.120, supplementary issue 1, pages 91 to 93	1-3

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP03/00675

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, X	WO 02/32883 A1 (Senju Pharmaceutical Co., Ltd.), 25 April, 2002 (25.04.02), & AU 2001/095951 A	1, 2
P, X	US 6423705 B2 (PFIZER Inc.), 23 July, 2002 (23.07.02), & EP 1226830 A2 & CN 1370531 A & AU 2002/011978 A & JP 2002-275096 A	1, 2

Form PCT/ISA/210 (continuation of second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP03/00675

Box I Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

- 1.
- ☒
- Claims Nos.: 4, 5

because they relate to subject matter not required to be searched by this Authority, namely:

Claims 4 and 5 pertain to methods for treatment of the human body by therapy and thus relate to a subject matter which this International Searching Authority is not required, under the provisions of Article 17(2)(a)(i) of the PCT and Rule 39.1(iv) of the Regulations under the PCT, to search.

- 2.
- ☐
- Claims Nos.:

because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

- 3.
- ☐
- Claims Nos.:

because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest ☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP03/00675

Concerning claims 1 and 2

Based on the descriptions "a compound inhibiting $\text{Na}^+/\text{Ca}^{2+}$ exchange transporter 1 (NCX1)" and "a compound specifically inhibiting $\text{Na}^+/\text{Ca}^{2+}$ exchange transporter 1 (NCX1)" as set forth in claims 1 and 2, it is unclear what compounds correspond thereto. Even though the description is taken into consideration, compounds SEA0064 and KB-R794, which correspond to neither the formula (1) nor the formula (2), are merely disclosed.

Concerning claims 1 and 2, therefore, prior documents were examined mainly focusing on the compounds disclosed in the description in this international search report.